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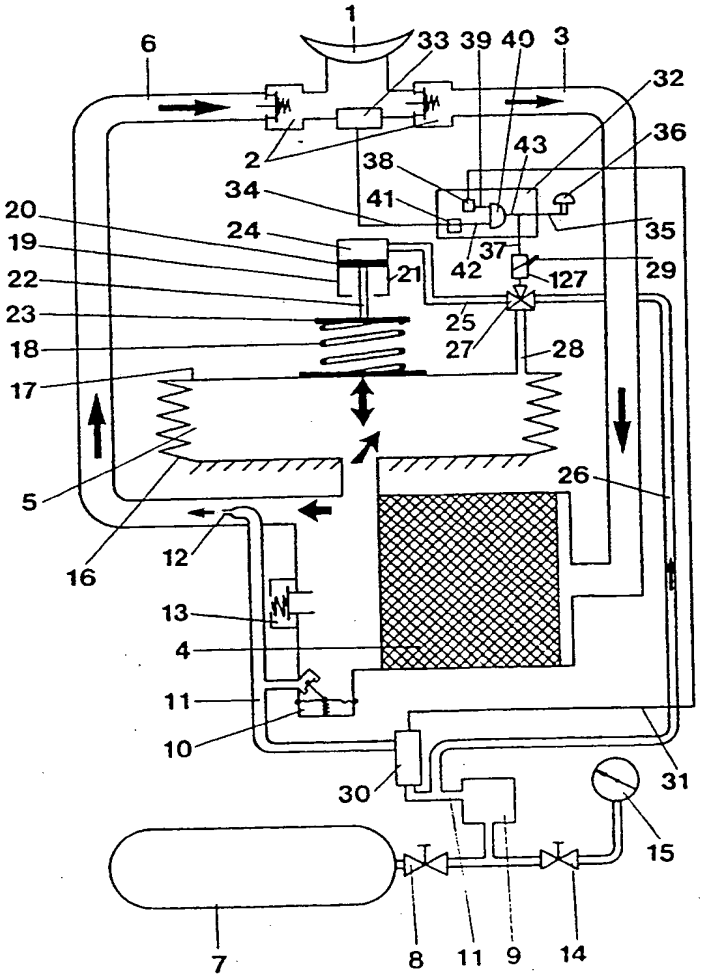
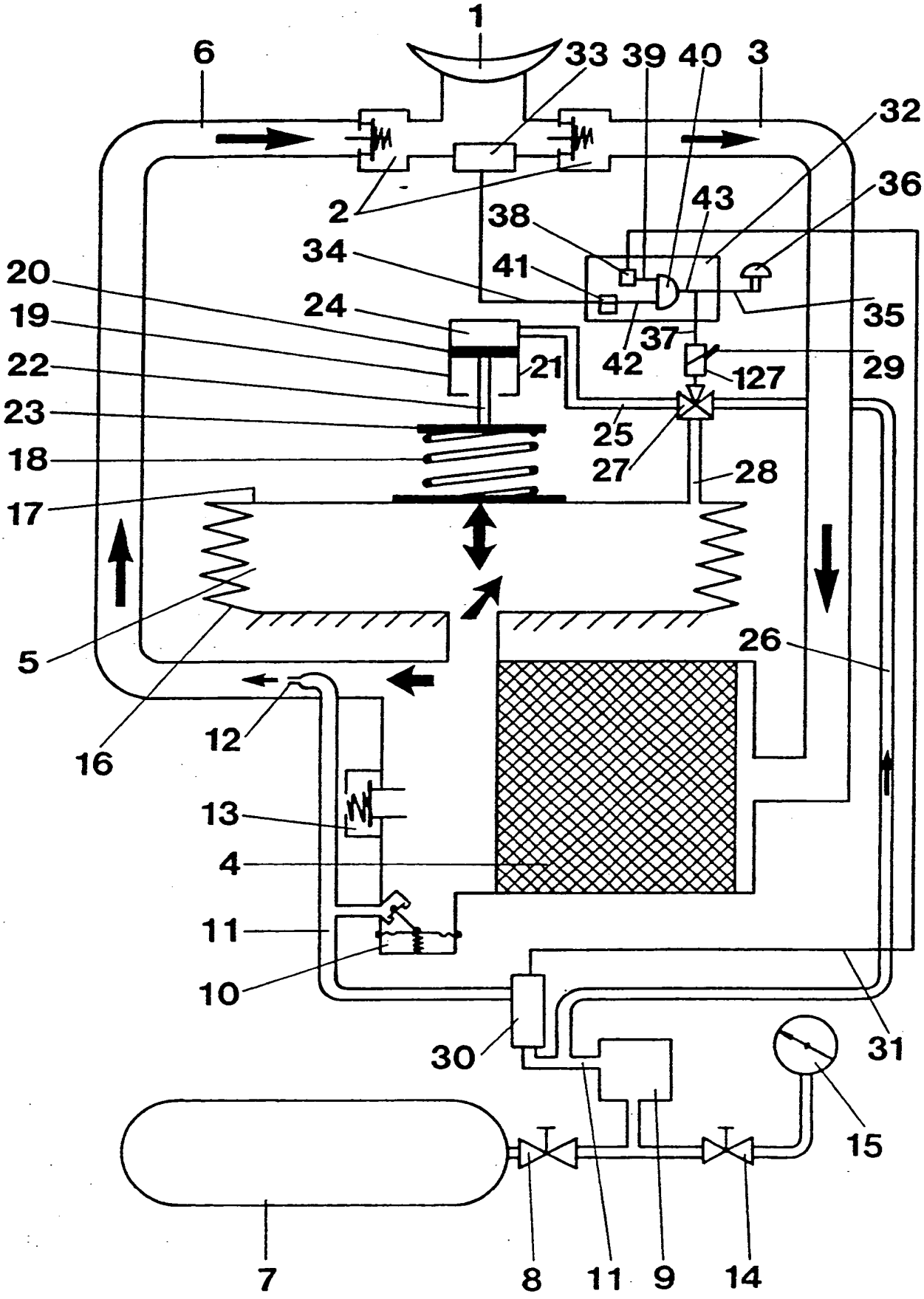
(54) Recirculatory respiratory protective apparatus

(57) A re-circulatory respiratory protective apparatus has means 19/20 for generating excess pressure therein, which means is inactivated in the event of an excessively high oxygen consumption, indicating a leak in the apparatus. A throughflow measuring device (30) is provided in the oxygen supply duct (11), and connected to a control unit (32). The control unit (32) is connected to a warning device (36) when oxygen flow reaches a first value, and at a second value a solenoid (127) actuates a valve (27) to inactivate a piston cylinder device (19, 20) which generates the excess pressure. The valve (27) may alternatively be actuated by a lever (29). The device (19, 20) acts on a respiratory bag (5) and is connected by a duct (25, 26) to a duct (11) between an oxygen pressure reducer (9) and the flow sensor (30).

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CIRCULATORY RESPIRATORY PROTECTIVE APPARATUS

This invention relates to a circulatory respiratory protective apparatus having means for generating excess pressure therein, which means is able to be inactivated in the event of an excessively high oxygen consumption.

If, in a circulatory respiratory protective apparatus designed to operate under excess pressure, a leak occurs, for example as a result of a badly placed respiratory mask, then, because of the high oxygen loss as a result of the excess pressure, the time of use of the apparatus is greatly reduced. A dangerous situation can thus arise for the wearer of the apparatus. If, in the case of leakage, the apparatus switches from excess pressure operation to normal operation, the oxygen loss is reduced.

Such a respiratory protective apparatus is known from DE-A-3229240. This apparatus has a blocking device for excess pressure operation, which device is automatically activated in the case of leakage. The blocking device is a cylinder-piston unit, wherein the motion of the piston is coupled with the motion of a respiratory bag. The force which the piston applies, by way of a lever, on the respiratory bag generates the excess pressure in the apparatus. The cylinder-piston unit has an outlet valve which opens when a given stroke position of the piston is exceeded so that the excess pressure in a chamber above the piston reduces, and the further supply of oxygen under pressure is prevented by means of an inlet valve activated by the pressure reduction in the chamber. In this way, the piston applies no more force on the respiratory bag and the apparatus functions in the normal operation. When the piston exceeds another given stroke position, the outlet valve is closed and the inlet valve is opened, and thus the force for generating the excess

pressure operation is again present. Disadvantages of this apparatus are that expensive mechanical construction and many sealing elements are required, that the existence of a leak is apparent only from a fixed position of the respiratory bag, and that there is no positive indication for the wearer of the apparatus that a leak is present.

The object of the present invention is to provide a circulatory respiratory protective apparatus with automatic excess pressure inactivation in the event of a leak, which can be realised without expensive mechanical construction, which enables a leakage recognition which is as clear as possible and which informs the wearer of the apparatus of the presence of a leak.

For solving this object, the apparatus has a throughflow measuring device in the course of the oxygen supply, which is connected with further components.

According to the present invention, there is provided a circulatory respiratory protective apparatus having means for generating excess pressure therein, which means is able to be inactivated in the event of excessively high oxygen consumption, wherein the apparatus comprises a throughflow measuring device for measuring the flow of oxygen to the apparatus.

The advantages of the invention reside in the fact that expensive mechanical constructions are not required, in the fact that, by the monitoring of the oxygen consumption, a leak can be recognised reliably, and in the fact that the possibility exists of making the wearer of the apparatus aware of the leak in the respiratory circuit. The throughflow measuring device detects the oxygen consumption directly at the source, without being impeded by components in the further course of the respiratory circuit.

The throughflow measuring device can be a flow sensor of a known constructional type, for example an impeller wheel flow sensor. It is preferably arranged in the low pressure part of the oxygen supply. On the other hand, a pressure sensor which measures the gas pressure in the oxygen source, e.g. an oxygen bottle, and which has a means for the summation of the pressure over time, can also be used since, with known bottle volumes, from the pressure reduction, the amount of oxygen supplied from the source can be calculated. In the case of a pressure sensor, this can be realised in addition to an additionally-provided pressure warning device.

The throughflow measuring device can be connected to a control unit in which the throughflow measured value is compared with a predeterminable limiting value. If the measured value exceeds the limiting value, the control unit emits a signal. This signal can be used to activate a warning device, e.g. a sound generator. In this way, the wearer of the apparatus is informed of an increased oxygen consumption. If the increased oxygen consumption is not caused by vigorous bodily activity of the wearer of the apparatus, then it must be assumed that a leak is present in the respiratory circuit. If this leak cannot be blocked, for example by correcting the seating of a slipped mask, the wearer of the apparatus can reduce the oxygen loss of the respiratory apparatus by manual inactivation of the means for generating the excess pressure.

In a preferred embodiment, the signal emitted by the control unit when the preset limiting value of the oxygen consumption is exceeded is used to activate a device which inactivates the means for generating the excess pressure without the wearer of the apparatus having to act. At the same time, a warning device is activated in order to inform the wearer of the

apparatus of the changed operational state of the apparatus and of the increased oxygen consumption.

The control unit can also be designed to recognize two limiting values of the oxygen consumption. When exceeding the first limiting value, the warning device is activated by a signal. The wearer of the apparatus can then decide himself whether or not he wants to inactivate the means for generating the excess pressure. When exceeding the second (higher) limiting value, the means for generating the excess pressure is automatically inactivated.

In order clearly to distinguish a leak in the apparatus from a high oxygen consumption of the wearer of the apparatus, the monitoring of the oxygen consumption by the throughflow measuring device can be synchronised with the exhalation phase of the wearer of the apparatus. An increased oxygen consumption detected in this phase can only be caused by a leak in the apparatus.

A pressure sensor in the respiratory circuit, preferably in the respiratory gas connector of the apparatus, can serve as a sensor for recognising the exhalation phase. During the inhalation phase, the pressure in the respiratory circuit reduces, and then increases again during the exhalation phase. Through these pressure variations, which can be recognised by the pressure sensor, the exhalation phase can be determined. The signal of the control unit that indicates an oxygen consumption lying above a preset limiting value can be linked with a signal marking the exhalation phase in a logic circuit, so that an output signal is produced only if, during the exhalation phase, the liming value of the oxygen consumption is exceeded. This limiting value can be selected to be substantially lower than in the aforementioned embodiments of the apparatus of the invention which

have no means for recognition of the exhalation phase. Thus it is possible to recognise even a small leak in the apparatus.

By the aforementioned output signal of the logic circuit, a device for inactivating the means for generating the excess pressure, and a warning device, can be activated.

The invention will now be described, by way of example, with reference to the single Figure of the drawing.

The circulatory respiratory protective apparatus represented schematically in the single Figure contains the components shown in functional arrangement and forming a respiratory circuit on a support frame (not shown) having an outer protective jacket (also not shown). These components are a respiratory connector 1 provided with non-return valves 2, an exhalation line 3, a regeneration cartridge 4 for binding the carbon dioxide present in the respiratory air, a respiratory bag 5 and an inhalation line 6. The oxygen consumed during respiration is replenished from an oxygen bottle 7 acting as a pressure gas source, via a bottle 8, a pressure reducer 9, an automatic lung device 10, a pipe line 11 and a constant dosing device 12, to the respiratory circuit, downstream of the respiratory bag 5. An excess pressure valve 13, downstream of the regeneration cartridge 4, prevents an unduly high pressure in the respiratory circuit. A manometer 15 is connected to the oxygen bottle 7 via a valve 14, for monitoring the oxygen supply.

The respiratory bag 5 consists of a bellows 16 having a mobile rigid end wall 17.

For generating an excess pressure in the respiratory circuit, there are provided a spring 18 and a simply-acting cylinder-piston unit 19 consisting of a piston 20 arranged in a cylinder 21 in a displaceable

manner. The cylinder 21 is open at the end facing the spring 18 and the displaceable piston 20 is connected by way of a piston rod 22 and a spring plate 23 to the end of the spring 18 facing away from the respiratory bag 5. The other end of the spring 18 rests on the end wall 17 of the respiratory bag 5.

Above the piston 20 there is a space 24 which is connected by way of a line 25 and a pressure gas line 26, to the pipe line 11.

The pressure gas line 26 contains, as a reverse valve, a magnetic valve 27 having an activating magnet 127, by means of which the pressure gas line 26 can be closed and can be separated from the space 24, whereby the magnetic valve 27 and a ventilating line 28 forms a connection between the space 24 and the respiratory bag 5. By means of a hand lever 29, the valve can be reversed by hand.

In the course of the pipe line 11, there is provided a throughflow measuring device 30 connected, by way of a signal line 31, to a control unit 32. In the respiratory connector 1, there is arranged a pressure sensor 33 which is connected, by way of a signal line 34, to the control unit 32. Also connected to the control unit 32, by way of a signal line 35, is a sound generator 36 acting as a warning device and, by way of a signal line 37, the magnetic valve 27.

In the normal excess pressure operational state of the respiratory protective apparatus, the magnetic valve 27 is connected such that the oxygen from the pressure reducer 9, via the pressure gas line 26 and the line 25, generates pressure in the cylinder-piston unit 19. The piston 20 thus moves to its lower end position and thus tightens the spring 18. The spring 18 thus applies a force on the end wall 17 of the respiratory bag 5, whereby an excess pressure occurs in the respiratory circuit.

The quantity of the oxygen fed into the respiratory circuit by the pipe line 11 is measured by the throughflow measuring device 30 acting as a flow sensor. The measured value is supplied, by way of a signal line 31, to the control unit 32 and evaluated by a limiting value circuit 38. If the measured value exceeds a preset limiting value, then the limiting value circuit 38 delivers a signal to one input 39 of a logic circuit 40.

As mentioned above, a pressure sensor 33 is arranged in the respiratory connector 1, which sensor measures the pressure in the respiratory connector 1.

The measured value is passed, by way of the signal line 34, to the control unit 32. By means of a limiting value circuit 41, the characteristic pressure increase for the exhalation phase of the wearer of the apparatus is recognised. The limiting value circuit 41 delivers a signal to a second input 42 of the logic circuit 40 during the exhalation phase.

The logic circuit 40 links both signals from its inputs 39 and 42 so that there is a signal at its output 43 if, during the exhalation phase, the preset limiting value of the oxygen quantity is exceeded. This signal clearly denotes a leak in the respiratory circuit. The output signal of the logic circuit 40 activates the sound generator 36 serving as a warning device, by way of the signal line 35. Through the signal of the sound generator 36, the wearer of the apparatus is made aware of the presence of a leak in the respiratory circuit so that he can try to take suitable counter measures. At the same time, the magnetic valve 27 is reversed by the output signal of the logic circuit 40. In this way, the space 24 is ventilated, the spring 18 is released and the excess pressure in the respiratory circuit is reduced, which in turn reduces the leak-associated oxygen loss to a

considerable extent. By means of the hand lever 29, excess pressure operation can also be inactivated manually.

CLAIMS

1. A circulatory respiratory protective apparatus having means for generating excess pressure therein, which means is able to be inactivated in the event of excessively high oxygen consumption, wherein the apparatus comprises a throughflow measuring device for measuring the flow of oxygen to the apparatus.

2. An apparatus according to claim 1, wherein the throughflow measuring device comprises a flow sensor.

3. An apparatus according to claim 1, wherein the throughflow measuring device comprises a pressure sensor adapted to be connected to a source of oxygen, the pressure sensor comprising means for the summation, over time, of the pressure in the source.

4. An apparatus according to any of claims 1 to 3, comprising a control unit for evaluating the value measured by the throughflow measuring device, which unit is able to emit a signal when a preset average oxygen consumption is exceeded.

5. An apparatus according to claim 4, wherein the control unit contains a logic circuit which is such that the signal emitted when the preset average oxygen consumption is exceeded is linked with a signal produced by a sensor for sensing the exhalation phase so that, when a preset average oxygen consumption is exceeded during the exhalation phase, a signal is emitted.

6. An apparatus according to claim 5, wherein the sensor for sensing the exhalation phase comprises a pressure sensor in the respiratory circuit.

7. An apparatus according to any of claims 4 to 6, comprising a warning device able to be activated by the signal from the control unit.

8. An apparatus according to claim 7, comprising a manually actuatable device for inactivating the means

for generating the excess pressure.

9. An apparatus according to any of claims 4 to 8, comprising a device able to be activated by the signal from the control unit, for inactivating the means for generating the excess pressure.

10. An apparatus according to claim 9, wherein the control unit is able to activate a warning device when a first preset average oxygen consumption value is exceeded and, when a second (higher) preset average oxygen consumption value is exceeded, to activate a device for inactivating the means for generating the excess pressure.

11. An apparatus according to claim 1, substantially as hereinbefore described with reference to, and as shown in, the drawing.

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